TRAWL SHRIMP INDEX FISHING IN THE SOUTHERN DISTRICT OF THE COOK INLET AREA

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By: Lee F. Hammarstrom

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TRAWL SHRIMP INDEX FISHING IN THE SOUTHERN DISTRICT OF THE COOK INLET AREA

MAY 10 - 12
and
MAY 15 - 19, 1989

Lower Cook Inlet Data Report Number 89-05

by

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INTRODUCTION

The commercial trawl shrimp fishery in the Cook Inlet Management Area (H) began with intermittent harvests in the 1950's and early 1960's, but the small catches did not accurately reflect the size of the stocks in the area. In the late 1960's trawl catches reached the five million pound level seasonally and remained near that level through the early 1980's (Table 1). More recently, the commercial fishery has been closed since the fall of 1986 due to low abundance levels. Pink shrimp (*Pandalus borealis*) have historically made up the bulk of the commercial catch, with sidestripes (*Pandalopsis dispar*) seasonally making up a lower but still significant portion of the catch. Humpy shrimp (*Pandalus goniurus*) have at times comprised up to 50 percent of the annual commercial harvest, but this species appears to undergo the most erratic population fluctuations and their contribution to the most recent fisheries have been minor. Finally, coonstripes (*P. hypsinotus*) have consistently made up approximately five percent of the harvest. Effort has varied from a low of one vessel during 1968 to a high of 23 in 1981.

Trawl shrimp population abundance index surveys have been conducted by the Department in the Southern District once each year (May) from 1971 through 1975 and twice annually (May and October) since then. Results of the surveys have been used to monitor stock status and establish harvest guidelines for each of the three regulatory sub-seasons (summer, fall, and winter) during the fishing year. During the spring of 1988, the number of stations east of Homer Spit was increased over previous years since this had become the major area of shrimp occurrence. Expanding the number of stations in this area also increases the statistical accuracy of the survey estimate of abundance.

METHODS

The spring 1989 trawl index survey was conducted aboard the state research vessel **PANDALUS** from May 10 through 12 and May 15 through 19, utilizing a 61-foot NMFS-designed net. This particular style of net, used in the surveys since 1975, replaced a 66-foot Nordby trawl net with assumed 50 percent net efficiency utilized during surveys conducted between 1971 through 1974. Based on side-by-side comparisons with the old net, the newer NMFS net has 100 percent assumed net efficiency.

Individual one nautical mile tows were made in systematically selected one-square mile stations throughout Kachemak Bay, Tutka Bay, and Sadie Cove. In recent years, to reduce the potential of net damage, one-half mile tows were utilized in stations west of Homer Spit which have had a recent history of no shrimp catch. If tows in the one-half mile stations indicate presence of shrimp, the tow is repeated with a length increase to the standard distance of one mile.

Upon completion of each tow, the total catch was weighed to the nearest two pounds using a digital electronic hanging scale and subsequently dumped on the rear deck. Two random subsamples of approximately 10,000 grams each were collected from individual tows of five hundred pounds or more; for catches of less than five hundred pounds, one such subsample was collected. Each bucket subsample was then separated by fish (which include finfish, shellfish, and any miscellaneous debris) and shrimp, and each of these groups was weighed to obtain percentages of the total catch. A 2,500 gram subsample was randomly selected from the shrimp in the original 10,000 gram subsample and separated by species, with each species weighed separately for species composition. In addition, small quantities of shrimp from the subsample were labelled and retained for later length frequency analysis in the laboratory. In the case of pink shrimp, which generally comprise the highest percentage of each shrimp subsample, a quantity of approximately 350 to 400 grams is retained from each station. For the other species, normally all individuals are retained since they usually amount to a relatively small number of shrimp per station subsample. For those catches which contained no shrimp, a basket sample of approximately 15,000 to 25,000 grams was collected in an attempt to better identify and enumerate the species composition of the fish.

RESULTS

A total of 31 successful tows in traditional stations only yielded an overall average catch of 90.5 pounds of Pandalid shrimp per one nautical mile tow (Table 2). For comparative purposes, when the eight newly added stations east of Homer Spit are included in the calculations, the average catch of shrimp in all stations amounted to 119.5 pounds per nautical mile. These figures do not include any catch data from the Tutka Bay/Sadie Cove areas since those areas are closed to commercial trawling. A tow was made in one traditional station at the mouth of Halibut Cove but no weights were taken because part of the net's cod end had partially pulled through the chaffing gear. This tow was not repeated because of the difficulty towing there without resultant net damage, therefore this station was not utilized for calculations.

Two one-half mile tows in each of two adjacent stations west of Homer Spit, combined into a single full mile tow, resulted in the capture of a significant amount of king crab along with a substantial quantity of bryozoans. In an attempt to reduce the injury and mortality to the king crab, the tow was released overboard without any weighing. Once again, neither tow was utilized for calculations.

The average catches of Pandalid shrimp per nautical mile by respective area were 342.8 pounds per tow east of the Homer Spit (traditional stations only), 287.4 pounds per tow east of the Homer Spit (all stations combined), 2.7 pounds per tow west of the Spit, and 508.0 pounds per tow in Tutka Bay/Sadie Cove (Table 3). The abundance index estimate for the Southern District based on the results of the spring 1989 survey for the traditional stations only ranged from 0.5 to 2.5 million pounds with a midpoint of 1.5 million pounds. Calculating in the non-traditional stations east of the Spit, the abundance index midpoint estimate is 2.0 million pounds, with a range of 0.8 to 3.2 million pounds. Formulas and explanations used to calculate the midpoint estimate and range are shown in Appendix Table 1.

Shrimp species composition is presented in Table 4. As expected pinks dominated the catches at 94.3 percent. Humpies comprised 1.4 percent of the catches, while sidestripes contributed only 2.0 percent of the total, the lowest percentage in the history of the spring survey. Coonstripes contributed only 1.4 percent to the catches. Incidence of "other" shrimp, such as *Crangon* sp. and *Eualis* sp. was approximately 0.9 percent. Preliminary average counts per pound for pink shrimp in the traditional stations east of the Homer Spit were 198 and 121, respectively, for the closed commercial waters north and northeast of Glacier Spit and the open commercial waters south and west of Glacier Spit (Table 5). West of Homer Spit, the average pink shrimp count per pound was 85 for the eight stations from which samples were obtained.

The largest catches of Pandalid shrimp in the survey once again occurred in the most northeasterly stations (Figure 1), with the largest being 1,714 pounds from a non-traditional station approximately 1.0 mile due west of Bear Cove (Table 6). Although dominated by pinks (88 percent), this particular station contained the highest percentage of humpy shrimp, at 10 percent, of any of the stations surveyed. Fourteen stations had a zero catch of shrimp, all west of Homer Spit. The catch from the single tow in Tutka Bay totalled 597 pounds, 92 percent of which was pinks and only 4 percent coonstripes.

Percentages of fish in the catches in the traditional stations only were 38.9 percent for the area east of the Homer Spit and 99.6 percent west of the spit (Table 7). The former figure is only slightly less than the record high of the previous spring survey. The two largest single station catches of fish occurred 1/4 and 2 miles due west of Hesketh Island, west of Homer Spit, totalling 2,900 and 2,700 pounds, respectively. The larger of the two catches contained over 70 percent pollock, weighing approximately 0.5 pounds each, and nearly 20 percent flathead sole. The smaller of the two contained over 90 percent pollock of a similar size. Two other stations west of the Spit had a fish catch in excess of 1,000 pounds, also containing mostly

pollock. The pollock at one of these stations, approximately 2.5 miles northwest of Yukon Island, weighed slightly more than one pound each.

One station east of the Spit, approximately 2.0 miles northeast of the Homer harbor, had a fish catch of nearly 1,800 pounds, consisting mostly of Tanner crab and kelp, shells, and debris. In Tutka Bay, the single tow contained 900 pounds of fish, most of which was herring that were later identified by a finfish biologist as being two years old.

The most commonly occurring fish species throughout the survey were flathead sole (*Hippoglossoides elassodon*), pollock (*Theragra chalcogramma*), and Pacific cod (*Gadus macrocephalus*). In terms of total weight, pollock represented the largest portion of the fish catches west of the Homer Spit, followed by flathead sole and Pacific cod (Table 8). East of the spit, kelp, shells, rocks, and other debris (all lumped together as one category) contributed the most weight to the "fish" category, followed by Tanner crab (*Chionocetes bairdi*) and flathead sole.

Gross stomach analysis was made on Pacific cod throughout the survey in random fashion. As a general rule, cod in the most northeasterly portion of Kachemak Bay were feeding heavily on Pandalid shrimp and some fish. Southwest from here, the percentages of shrimp in the stomach contents decreased while the fish and Tanner crab percentages increased. West of Homer Spit, stomachs contained mostly fish and/or Tanner crab. Fewer pollock stomachs were analyzed, with this species feeding primarily on either euaphaasids or shrimp larvae (positive identification unknown).

DISCUSSION

The average catches of shrimp during the spring survey of 1989 from the area east of Homer Spit and from Tutka Bay/Sadie Cove are decreases from the previous fall survey, and all areas experienced significant decreases from the 1988 spring survey. The resulting abundance midpoint estimate of 1.5 million pounds is the lowest midpoint in the history of the survey program. Examination of Figure 1 shows that the majority of the shrimp caught in the survey were from four stations located in the closed commercial area north and east of Glacier Spit, with an average of 990 pounds of Pandalid shrimp caught per station. Fish catches in these stations averaged 279 pounds per tow. The average shrimp catch in the ten successful tows made west and south of Glacier Spit, the open commercial area, was only 22 pounds, while fish averaged 313 pounds per tow. Average catches of shrimp west of Homer Spit were once again very poor, similar to recent years' surveys. Fish catches were also very high west of the Spit, with an average of 671 pounds per tow.

Count per pound data collected in the field suggests that the pink shrimp found in the closed commercial area are predominantly juveniles and males, supporting the "nursery" or rearing area theory used to justify this closed area. However, the shrimp here were larger than in previous spring surveys, perhaps suggesting that there were fewer of the very small, juvenile shrimp. The open commercial area counts per pound suggest that shrimp in this area are primarily transitionals and females, but catches in this area were extremely small and contained high percentages of fish. West of the Spit the small counts indicate mostly transitionals and females.

Shrimp survival and reproductive success appear to have been poor over the past year. Relatively few of the very small, juvenile shrimp were encountered in field observations during the survey. Numbers of pink shrimp females still appear to be relatively low, and the pink shrimp have not expanded significantly into the open commercial area east of Homer Spit, a traditional area of formerly high commercial harvest. Incidence of fish species also remains extremely high.

Current environmental factors seem to be the primary element influencing the pink shrimp stocks in Kachemak Bay. Gross stomach analysis of Pacific cod during the survey indicates a high predation level by this species on shrimp, also contributing to the suppression of the shrimp stocks. The Department has no control over these factors but can control the additional factor of fishing mortality. Enhancing shrimp reproductive success and survival could be accomplished by continuing to eliminate fishing mortality and reducing predation levels.

Table 1. Historical trawl shrimp catches by guideline harvest level for the Kachemak Bay trawl shrimp fishery in the Cook Inlet Management Area (H).

SEASON	NUMBER OF VESSELS	CATCH (lbs) JUN 1-OCT 31	NOV 1-MAR 31	APR 1-MAY 31	TOTAL
1968-70[a]	7	1,289,656	1,692,854	889,330	3,871,840
1970-71[a]	3	3,211,924	2,076,228	617,836	5,905,988
1971-72[a]	7	2,618,630	1,761,569	140,707	4,520,906
1972-73[a]	10	2,772,422	2,109,660		4,882,082
1973-74[b]	13	2,502,154	2,323,780		4,825,934
1974-75	4	2,512,764	2,519,148		5,031,912
1975-76	4	1,997,563	2,421,456		4,419,019
1976-77	5	2,545,885	2,453,101		4,998,986
1977-78	7	2,490,969	2,546,977		5,037,946
1978-79	6	2,952,733	3,060,066		6,012,799
		JUL 1-SEP 30	OCT 1-DEC 31	JAN 1-MAR 31	
1979-80	7	2,013,298	2,052,646	1,731,483	5,797,427
1980-81	15	1,780,298	2,691,746	1,704,706	6,177,129
1981-82	23	1,614,868	1,686,781	1,693,850	4,995,499
1982-83	15	998,522	1,012,388	1,009,857	3,020,767
1983-84	10	CLOSED	CLOSED	525,508	525,508
1984-85	10	519,651	528,506	518,529	1,566,686
1985-86	5	488,606	257,782	503,340	1,249,728
1986-87	3	504,206	CLOSED	CLOSED	504,206
1987-88	0	CLOSED	CLOSED	CLOSED	0
1988-89	0	CLOSED	CLOSED	CLOSED	0

[a] Catches listed for comparative purposes by seasons established in 1973.
[b] June 1 - October 31 and November 1 - March 31 seasons with respective guidelines established.

Table 2. Abundance index estimates of commercial species of Pandalid shrimp (millions of pounds) in the Southern District (Kachemak Bay), by sampling period and year, based on pounds of shrimp caught per one nautical mile tow.

MONTH	YEAR	MEAN CATCH (lbs/tow)	NUMBER OF STATIONS	% ERROR	ABUNDANCE INDEX (Mill. of lbs.)	(Mill. of lbs.)
SPRING						
May	1971	130.2*	56	20.0	3.7	3.0 to 4.5
May	1972	271.1*	66	35.5	7.7	5.0 to 10.5
May	1973	592.8*	59	27.8	16.9	12.2 to 21.6
Jun	1974	476.6*	30	22.8	13.6	10.5 to 15.7
May	1975	1,136.9*	37	27.9	16.2	11.7 to 20.7
May	1976	541.3	36	28.3	7.7	5.5 to 9.9
Jun	1977	407.9	40	17.1	5.8	4.8 to 6.8
May	1978	810.9	36	25.2	11.5	8.6 to 14.5
May	1979	743.7	41	20.9	10.6	8.4 to 12.8
May	1980	513.7	39	19.5	7.3	5.9 to 8.7
May	1981	486.1	37	18.4	6.9	5.6 to 8.2
May	1982	306.8	38	21.8	4.4	3.4 to 5.3
May	1983	204.0	37	24.8	2.9	2.2 to 3.6
May	1984	282.3	34	34.2	4.1	3.0 to 5.2
May	1985	197.5	34	39.7	3.2	1.9 to 4.5
May	1986	157.2	34	50.9	2.6	1.3 to 4.0
May	1987	178.8	34	45.2	3.0	1.6 to 4.3
May	1988	247.5	33	45.0	4.1	2.3 to 6.0
May	1989	90.5	31	65.9	1.5	0.5 to 2.5
FALL						
Oct	1976	719.8	33	21.6	10.3	8.0 to 12.5
Nov	1977	738.1	36	28.9	10.5	7.5 to 13.5
Oct	1978	1,160.3	32	25.5	16.5	12.3 to 20.7
Oct	1979	1,133.3	32	23.3	16.1	12.4 to 19.9
Oct	1980	1,689.4	37	19.3	24.1	19.4 to 28.7
Oct	1981	604.8	35	26.9	7.9	5.8 to 10.0
Oct	1982	519.2	36	26.3	7.4	5.4 to 9.3
Oct	1983	481.3	36	36.6	6.9	4.9 to 8.8
Oct	1984	531.9	35	26.3	7.6	6.1 to 9.1
Oct	1985	284.9	34	32.0	4.1	2.8 to 5.4
Sep	1986	154.0	34	37.9	2.6	1.6 to 3.6
Sep/Oct	1987	227.0	34	66.1	3.8	1.3 to 6.3
Nov	1988	152.3	28	64.8	2.5	0.9 to 4.2

*66' Nordby net, 50% assumed net efficiency.
*From this survey to present, a 61' NMFS net with 100% assumed net efficiency has been used.

Table 3. Mean catch of Pandalid shrimp in pounds per one nautical mile tow, by area, by period, and by year, captured during trawl shrimp index surveys in the Southern District (Kachemak Bay) of the Cook Inlet Management Area (H).

Month	Year	MEAN CATCH OF PANDALID SHRIMP (lbs/tow) West of Spit	East of Spit	Tutka/Sadie[a]
SPRING				
May	1971[b]	126.5	69.3	
May	1972[b]	366.9	75.7	
May	1973[b]	759.2	156.1	
Jun	1974[b]	492.1	211.2	
May	1975[b]	1,250.0	660.0	
May	1976	479.6	802.0	
Jun	1977	317.6	678.7	
May	1978	749.5	1,175.7	
May	1979	786.0	633.9	
May	1980	488.1	539.2	
May	1981	454.5	584.7	1,492.3
May	1982	268.6	413.3	452.0
May	1983	97.2	536.2	1,830.8
May	1984	56.0	910.0	1,179.8
May	1985	2.6[d]	830.4	2,027.0
May	1986	2.0[d]	588.4	1,102.9
May	1987	24.0[d]	609.0	714.3[e]
May	1988	39.1[d]	898.9	2,006.0[f]
May	1989	2.7	342.8	508.0

[a] The Tutka/Sadie area was not surveyed prior to 1981.
[b] Nordby trawl net (66' ground rope, 53' head rope, 60' tickler chain) with 50% assumed net efficiency.
[c] From this survey to present, a 61' NMFS net with 100% assumed net efficiency has been used.
[d] Extremely small shrimp catches (less than 10% of total) were not processed for actual weight and are referred to as "trace shrimp", and are considered zero for calculations.
[e] Only 2 of the 3 tows in Sadie Cove included.
[f] Only one tow in Sadie Cove made and its weight was estimated due to a malfunctioning electronic scale.

Month	Year	MEAN CATCH OF PANDALID SHRIMP (lbs/tow) West of Spit	East of Spit	Tutka/Sadie[a]
FALL				
Oct	1976	574.7	1,127.0	
Nov	1977	695.6	456.6	
Oct	1978	1,310.2	626.0	
Oct	1979	1,263.7	805.6	
Oct	1980	1,764.4	1,456.2	
Oct	1981	626.6	541.9	734.0
Oct	1982	303.4	1,274.4	1,309.5
Oct	1983	48.1	1,607.6	3,492.3
Oct	1984	305.7	1,185.5	2,741.0
Oct	1985	88.8	829.8	876.9
Sep	1986	18.0[b]	518.9	1,188.9
Sep/Oct	1987	2.0[b]	852.0	667.7
Nov	1988	1.3[b]	471.0	597.5[c]

[a] The Tutka/Sadie area was not surveyed prior to 1981.
[b] Extremely small shrimp catches (less than 10% of total) were not procesed for actual weight and are referred to as "trace shrimp", and are considered zero for calculations.
[c] Only 1 tow made in Sadie Cove.

Table 4. Catch composition (percent) of Pandalid shrimp species in the Southern District (Kachemak Bay) trawl abundance index surveys by sampling period and year. "Other" shrimp (Crangon sp. and Eualis sp.) are additional to those years where figures do not add up to 100 percent.

YEAR	MONTH	PINK	HUMPY	COON	SIDE	ABUNDANCE INDEX (Million lbs.)
SPRING						
1971	May	83.8	9.9	1.9	4.4	3.7
1972	May	62.0	33.2	1.3	3.5	7.7
1973	May	67.5	27.3	1.8	3.4	16.9
1974	Jun	81.6	7.9	2.2	8.3	13.6
1975	May	74.8	16.6	2.7	5.9	16.2
1976	May	82.6	5.3	3.6	8.5	7.7
1977	Jun	83.4	3.3	6.1	7.2	5.8
1978	May	67.9	24.8	1.3	6.1	11.5
1979	May	78.3	14.3	2.3	5.1	10.6
1980	May	63.4	23.6	1.9	11.1	7.3
1981	May	72.7	13.8	4.2	9.3	6.9
1982	May	73.2	12.6	3.4	10.8	4.4
1983	May	71.3	1.4	1.4	25.9	2.9
1984	May	85.4	1.8	0.9	11.8	4.1
1985	May	89.0	1.6	1.0	8.4	3.2
1986	May	70.6	7.4	1.3	20.1	2.6
1987	May	78.3	10.1	2.1	9.6	3.0
1988	May	67.5	17.9	2.2	10.5	4.1
1989	May	94.3	1.4	1.4	2.0	1.5
FALL						
1976	Oct-Dec	69.0	20.8	3.0	7.2	10.3
1977	Nov	58.1	29.2	2.0	10.7	10.5
1978	Oct	47.4	45.9	1.7	5.0	16.5
1979	Oct	45.2	50.4	0.7	3.7	16.1
1980	Oct	57.8	34.5	1.5	6.2	24.1
1981	Oct	57.8	30.4	1.6	10.2	7.9
1982	Oct	71.2	16.0	2.5	10.3	7.4
1983	Oct	72.1	15.4	2.6	9.8	6.9
1984	Oct	68.4	19.8	2.9	8.9	7.6
1985	Oct	71.7	1.1	2.9	19.2	4.1
1986	Sep	75.5	2.3	3.9	12.1	2.6
1987	Sep/Oct	63.6	8.5	3.0	19.4	3.8
1988	Nov	78.1	10.3	3.2	4.9	2.5

Table 5. Historical average numbers of pink shrimp (*Pandalus borealis*) per pound by area from samples taken during ADF&G trawl index surveys in the Southern District (Kachemak Bay) of the Cook Inlet Management Area (H).

Year	East of Homer Spit: Open Commercial Area Pink Count/lb.	East of Homer Spit: Closed Commercial Area Pink Count/lb.	East of Homer Spit: Combined Avg. Pink Count/lb.	West of Homer Spit Pinks/lb.	Combined Avg. All Areas Pinks/lb.*
Spring Survey					
1971	230.3	213.4	220.0	159.6	180.4
1972	185.3	203.1	196.7	137.3	161.9
1973	230.4	167.2	182.5	152.0	158.5
1974	133.8	125.6	129.5	126.0	126.8
1975	154.6	143.5	150.0	135.9	138.1
1976	169.6	157.8	165.9	107.5	126.7
1977	144.7	142.7	143.5	109.0	120.5
1978	155.0	163.6	158.6	123.7	130.2
1979	170.7	203.3	185.1	126.6	147.1
1980	173.6	190.1	181.7	112.0	127.5
1981	193.1	190.9	192.2	111.7	134.9
1982	180.8	177.2	178.7	112.8	129.2
1983[May/Jun]	151.3	176.2	164.0	102.6	128.3
1983[Jul]	169.3	194.4	177.0	108.7	161.0
1984	177.5	224.2	206.7	98.5	142.6
1985	193.8	244.3	220.9	199.0	218.2
1986	155.5	229.4	200.5	NO SAMPLES	200.5
1987	134.8	271.4	212.6	108.5	204.7
1988	107.5	247.3	209.8	95.0	175.5
1989	121.3	197.7	184.4	85.0	176.3

-Continued-

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Year	East of Homer Spit: Open Commercial Area Pink Count/lb.	East of Homer Spit: Closed Commercial Area Pink Count/lb.	East of Homer Spit: Combined Avg. Pink Count/lb.	West of Homer Spit Pinks/lb.	Combined Avg. All Areas Pinks/lb.*
Fall Survey					
1976	NO SAMPLES	144.1	144.1	112.5	123.0
1977	NO SAMPLES	164.0	164.0	144.1	152.7
1978	148.1	159.6	155.0	133.4	140.3
1979	149.8	NO SAMPLES	149.8	135.0	138.4
1980	150.8	183.0	173.3	135.4	144.2
1981	112.9	182.0	154.2	127.2	139.5
1982	202.0	181.9	191.1	106.8	149.5
1983[Oct]	198.9	232.7	217.8	146.2	200.9
1983[Dec]	118.3	218.4	170.2	NO SAMPLES	170.2
1984	183.8	205.8	196.3	142.6	168.9
1985	190.0	246.7	234.7	247.5	239.1
1986	215.3	230.7	223.2	131.4	207.7
1987	115.0	184.0	152.0	NO SAMPLES	152.0
1988	109.5	146.5	138.8	83.1	138.6

*Does not include any samples from the Tutka Bay/Sadie Cove area.

Table 6. Catches by station in pounds per one nautical mile tow in the Southern District (Kachemak Bay) during the spring trawl shrimp index survey, May 10-12 and May 15-19, 1989 (61-foot high opening NMFS net).

TOW NO.	DEPTH (fm)	STATION NO.	SHRIMP Pink	Humpy	Coon	Side	Other*	Total Lbs.	%	FISH Total Lbs.	%
West of Homer Spit											
1*	36-40	H05	---	---	---	---	---	0	----	222	100.0
2*	48-46	H07	---	---	---	---	---	0	----	340	100.0
3*	46-44	H08	---	---	---	---	---	0	----	340	100.0
4*	56	I09	---	---	---	---	---	0	----	312	100.0
5*	35-34	J07	---	---	---	---	---	0	----	972	100.0
6*	43-45	K09	---	---	---	---	---	0	----	170	100.0
7*	45-44	L09	---	---	---	---	---	0	----	286	100.0
8*	44-43	L10	---	---	---	---	---	0	----	286	100.0
9*	41-43	K11	---	---	---	---	---	0	----	222	100.0
30	88-92	K16	1	0	0	1	T	2	1.9	124	98.1
31	26-30	J15	---	---	---	---	---	0	----	24	100.0
32	43-50	I14	---	---	---	---	---	0	----	796	100.0
33	44-49	H14	T	---	---	---	---	T	----	2,884	100.0
34	63-65	L17	1	0	0	1	T*	2	0.3	734	99.7
35	58-63	L16	7	0	0	2	1	10	3.0	332	100.0
36	48	L15	3	0	0	1	0	4	0.5	746	99.5
37	52-48	L13	---	---	---	---	---	0	----	1,060	100.0
38	55-69	K14	14	0	0	2	T	16	4.8	324	95.2
39	88-81	K15	2	0	0	3	0	5	0.7	680	99.3
40*	63-56	J13	22	0	0	1	T	23	5.1	421	94.9
41*	45	J11	---	---	---	---	---	0	----	1,200	100.0
42*	60-61	I12	1	0	0	0	0	1	0.3	227	99.7
43*	53-40	H12	---	---	---	---	---	0	----	2,736	100.0
44*	43-56	H11	NO WEIGHTS TAKEN*								
45*	56-46	H10	NO WEIGHTS TAKEN*								
Subarea											
Total			51	0	0	11	1	63	0.4	15,438	99.6
Percent			81.0	0	0	17.5	1.6				
Mean per tow			2.2	0	0	0.5	T	2.7	0.4	671.2	99.6

*Includes other shrimp such as Crangon sp. and Eualis sp.
*One-half mile tow doubled to represent standard one mile tow.
*"Other shrimp" in this tow include only one *P. platyceros* individual and one *P. danae* individual.
*The catch in this tow, mostly bryozoans and king crab, was released to reduce injury to the king crab. This tow was not used in any calculations.

Table 6, page 2 of 3.

TOW NO.	DEPTH (fm)	STATION NO.	SHRIMP Pink	Humpy	Coon	Side	Other*	Total Lbs.	%	FISH Total Lbs.	%
East of Homer Spit (Traditional)											
10	25-27	R24	225	2	2	T	2	231	54.7	191	45.3
12[b]	24-28	S25	435	5	12	1	5	458	70.7	190	29.3
13	25-29	T26	1,234	23	6	23	8	1,294	81.5	294	18.5
20	30-34	R25	474	8	11	15	4	512	64.8	278	35.2
21	30-31	Q24	175	2	8	1	1	187	55.8	149	44.2
23	27-32	O24	NO WEIGHTS TAKEN[c]								
24	40-41	O22	55	T	T	5	2	62	24.6	190	75.4
26	50-45	N22	6	T	0	2	T	8	3.2	236	96.8
29	45	N21	12	T	0	T	2	14	5.6	234	94.4
Subarea											
	Total		2,616	40	39	47	24	2,766	61.1	1,762	38.9
	Percent		94.6	1.4	1.4	1.7	0.9				
	Mean per tow		327.0	5.0	4.9	5.9	3.0	345.8	61.1	220.3	38.9
Kachemak Bay											
	Total		2,667	40	39	58	25	2,829	14.1	17,200	85.9
	Percent		94.3	1.4	1.4	2.0	0.9				
	Mean per tow		86.0	1.3	1.3	1.9	0.8	91.3	14.1	554.8	85.9
Tutka Bay/Sadie Cove[d]											
27	41-48	C/D20	558	13	26	0	6	603	40.2	897	59.8
28	44-37	H18	410	4	5	T	1	420	21.1	1,566	78.9
	Total		968	17	31	0	7	1,023	29.3	2,463	70.7
	Percent		94.6	1.7	3.0	0	0.7				
	Mean per tow		484.0	8.5	15.5	0	3.5	511.5	29.3	1,231	70.7

*Includes other shrimp such as Crangon sp. and Eualis sp.
[b]The first tow at this station was unsuccessful and was repeated.
[c]Unsuccessful tow, not repeated because this station has historically been difficult to complete. Not used in calculations.
[d]Tutka/Sadie are not included in the Kachemak Bay index, but serve as an indication of localized productivity.

Table 6, page 3 of 3.

TOW NO.	DEPTH (fm)	STATION NO.	SHRIMP Pink	Humpy	Coon	Side	Other[a]	Total Lbs.	%	FISH Total Lbs.	%
East of Spit (Non-traditional)											
14	24-26	U27	1,521	169	0	24	14	1,728	83.0	354	17.0
15	29-30	O20	4	1	16	0	12[b]	33	1.8	1,761	98.2
16	24-31	P21	3	T	4	T	3	10	2.9	342	97.1
17	31-29	P22	10	T	4	T	9	23	3.0	733	97.0
18	32-33	P23	45	T	2	8	18[c]	73	14.7	423	85.3
19	37	N20	10	0	T	T	3[c]	13	5.5	223	94.5
22	42-37	O23	16	T	2	14	0	32	11.8	240	88.2
25	34-36	O21	4	0	T	T	1[c]	5	1.4	363	98.6
Subarea											
Total			1,613	170	28	46	60	1,917	30.2	4,439	69.8
Percent			84.1	8.9	1.5	2.4	3.1				
Mean per tow			201.6	21.3	3.5	5.8	7.5	239.6	30.2	554.9	69.8

[a] Includes other shrimp such as Crangon sp. and Eualis sp.
[b] Includes approximately one pound of *P. platyceros*.
[c] Includes a trace of *P. platyceros*.

Table 7. Percent composition of fish during trawl shrimp index surveys in the Southern District (Kachemak Bay) based on catches of fish and shrimp per one nautical mile tow, by sampling period and year.

YEAR	EAST OF SPIT (241-13, 14, 15) MAY	EAST OF SPIT (241-13, 14, 15) OCT	WEST OF SPIT (241-11 and 241-12) MAY	WEST OF SPIT (241-11 and 241-12) OCT
1972	36.2		5.5	
1973	22.2		7.9	
1974	6.9		3.9	
1975	10.6		9.0	
1976	9.0	11.9	16.1	13.8
1977	8.6	20.3	30.4	18.7
1978	29.4	14.8	19.6	16.7
1979	18.6	16.7	12.8	17.5
1980	10.7	17.7	13.7	16.1
1981	5.1	38.2	35.2	40.8
1982	19.1	35.4	32.1	64.5
1983	30.4	42.0	59.5	87.9
1984	18.0[a]	35.3	75.0[a]	57.0
1985	7.4	22.0	99.3	92.9
1986	10.8	18.1	99.3	94.3
1987	23.2	42.1	90.4	99.8
1988	40.4	60.6[b]	94.4	99.9[b]
1989	38.9		99.6	

[a]Does not include large cod and halibut.
[b]Survey actually occurred Nov. 13-19 aboard R/V RESOLUTION.

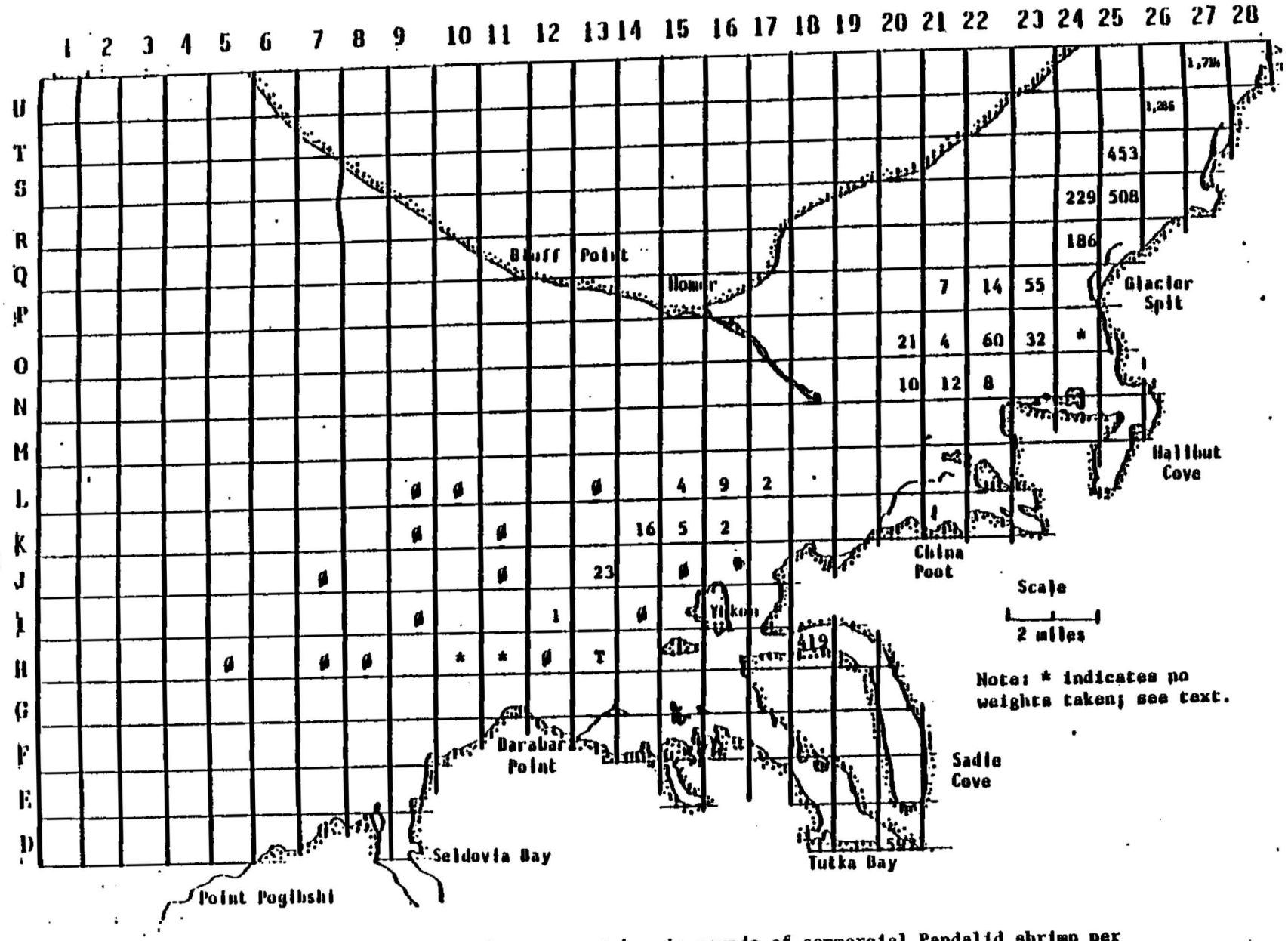

Figure 1. Kachemak Bay shrimp trawl survey catches in pounds of commercial Pandalid shrimp per one nautical mile tow (61' high opening NMFS net, R/V PANDALUS) during May 10-12 and May 15-19, 1989.

Table 8. Breakdown of fish catches by species in the Southern District (Kachemak Bay) trawl shrimp index of abundance survey, May 10-12 and May 15-19, 1989.

Fish Species	EAST OF SPIT (5 Tows) Occurrence # of Tows	Total Lbs.	% of Total	WEST OF SPIT (23 Tows) Occurrence # of Tows	Total Lbs.	% of Total
Halibut	3	117	4.2	11	262	1.7
Pacific cod	3	125	4.5	12	598	3.9
Pollock	5	169	6.1	17	7,706	50.0
Flathead sole	5	384	13.9	20	3,154	20.5
Arrowtooth flounder	3	14	0.5	19	462	3.0
Rex sole	0	0	0	11	153	1.0
Dover sole	1	T	T	8	85	0.5
Rock sole	0	0	0	9	372	2.4
Butter sole	0	0	0	4	61	0.4
Yellowfin sole	2	15	0.5	5	88	0.6
English sole	0	0	0	1	48	0.3
Blackcod	0	0	0	5	46	0.3
Tomcod	2	46	1.7	8	160	1.0
Smelt	4	11	0.4	8	11	0.1
Sculpins/ Irish Lords	5	231	8.4	13	344	2.2
Poachers	0	0	0	2	1	T
Tanner crab	3	608	22.0	4	272	1.8
Dungeness crab	1	104	3.8	0	0	0
Starry flounder	1	21	0.7	1	679	4.4
Pricklebacks	2	1	T	3	13	0.1
Skates	0	0	0	4	153	1.0
Herring	0	0	0	3	5	T
Searchers	0	0	0	2	3	T
Rockfish	0	0	0	8	224	1.4
Alaska plaice	1	44	1.6	0	0	0
Eelpouts	2	5	0.2	9	24	0.2
Capelin	1	1	T	4	1	T
Hind's scallop	0	0	0	4	5	T
Kelp/rocks/ shells/debris	3	870	31.5	15	486	3.2
TOTALS	5	2,764	100.0	23	15,417	100.0

Appendix Table 1. Formulas and explanations for calculations of abundance estimate and range for Pandalid shrimp in the Southern District of the Cook Inlet Management Area (H).

$$\text{Mean shrimp catch} = \frac{\sum_{i=1}^{N} x_i}{N} = \bar{x}$$

Area - total area (Nm^2) considered = A

Total number of tows = N

$$\text{Sample variance (SV)} = \frac{1}{N-1} \sum_{i=1}^{N} (x_i - \bar{x})^2$$

where $x_1, x_2, \ldots\ldots, x_N$ are the standardized (1 nm) catches of shrimp from each tow.

$$\text{Standard deviation (SD)} = \sqrt{SV}$$

$$\text{Standard error of the mean (SE)} = SD / \sqrt{N}$$

$$\text{Population estimate (p)} = \left(\frac{6076}{32} \times A\right) \bar{x}$$

$$\text{Standard deviation of the population estimate (Sp)} = \frac{(6076}{32} \times A) \; SE$$

$$\text{Percent error} = \frac{1.3 \times SE}{\bar{x}} \times 100$$

Notes: 6,076 is the number of feet in a nautical mile; 32 is the effective width of the net; 88 is the area of the stratum (A) in square nautical miles; and x is the mean catch.

Percent error: 1.3 is the value from the Normal distribution statistical table giving an approximate 80% confidence interval.

Source: Watson, Leslie. 1981. Shrimp trawl survey manual. May 1, 1981. ADF&G, Kodiak, AK. 44pp.